URODYNAMIC RESULTS OF LASER TREATMENT IN PATIENTS WITH BENIGN PROSTATIC HYPERPLASIA. CAN OUTLET OBSTRUCTION BE RELIEVED?


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ABSTRACT

Purpose: A urodynamic study was done to judge the capability of laser treatment to relieve bladder outlet obstruction.

Materials and Methods: Advanced urodynamic studies with pressure-flow analysis were performed before and 6 months after laser treatment using 3 different laser devices.

Results: Forty patients showed significant improvement in all obstruction parameters (detrusor pressure at maximum flow rate, urethral resistance relation, theoretical cross-sectional urethral area, minimal detrusor pressure and linear passive urethral resistance relation) together with significant subjective improvement in international prostate symptom score. After treatment 82 to 92% of the patients could no longer be considered to have obstruction. No difference in outcome among the devices used was found.

Conclusions: Laser prostatectomy is indeed capable of relieving bladder outlet obstruction.

KEY WORDS: prostatic hypertrophy, urodynamics, prostatectomy, lasers

For more than 7 decades prostates have been enucleated surgically and for almost 6 decades they have been resected endoscopically. Results have been impressive and increasingly better, and the procedures are reasonably safe. In the 1980s many alternatives to prostatectomy have surfaced, from a pharmacological approach to numerous procedural alternatives, for example balloon dilation, prostatic stents, hyperthermia and thermotherapy. To date, none of these alternatives has reached subjective and objective results comparable to those noted after enucleation or resection of the prostate. Nevertheless, the morbidity of the operations is still greater than that for any of these alternatives.

Recently, a new instrumental treatment modality for benign prostatic hyperplasia (BPH) became available, that is laser treatment of the prostate. The advantages of laser treatment are the minimal hospital stay, minimal bleeding, no fluid absorption, rapidity of treatment, technical simplicity and chance of preservation of antegrade ejaculation. Although present studies include few patients and the follow-up is short, the results after laser treatment are comparable to those achieved after electroresection. To replace transurethral resection of the prostate by laser prostatectomy, the latter procedure should also be able to relieve outlet obstruction. In general patients are evaluated preoperatively and postoperatively by means of symptom scores, uroflowmetry studies, post-void residual volume and prostate size. These parameters are associated with obstructive voiding but not with the grade of obstruction and, therefore, they cannot be used to determine objectively whether outlet obstruction is relieved. To quantify the grade of bladder outlet obstruction, urodynamic investigation with pressure-flow analysis is considered the gold standard. We judged the obstruction relieving capabilities of laser treatment of the prostate.

PATIENTS AND METHODS

Since November 1992 we treated 125 patients with 3 different laser systems: the Intra Sonix TULIP device, the Bard Urolase fiber and the Heraeus Ultraline fiber. All patients underwent a screening program consisting of physical examination (including digital rectal examination), biochemistry (including prostate specific antigen [PSA]), and urine culture and sedimentation rate. Transrectal ultrasound of the prostate was performed with planimetric measurement of the prostate volume. Furthermore, renal ultrasound was done to exclude hydronephrosis. All patients underwent urocytoscopy to measure the prostate length, and to assess the size of the middle and lateral lobes. In case of a suspicious digital rectal examination, transrectal ultrasound or an elevated PSA level (greater than 10 ng./ml. or a PSA density of more than 0.15), prostate biopsies were obtained to exclude malignancy. To evaluate the subjective parameters before and after the operation all patients had to complete an international prostate symptom score questionnaire and the symptom score had to be at least 12. Objective parameters were evaluated by a free urinary flow rate using a Dantec Uroflowmeter. The voided volume had to be at least 150 ml. The post-void residual volume, measured by transabdominal ultrasonography, had to be less than 350 ml. If patients fit these criteria, they were eligible for laser treatment. Urodynamic investigations were performed with an 8F transurethral lumen catheter with an intravesical micro-tip pressure sensor. Abdominal pressure was recorded intrarectally with a transurethral lumen catheter with an intravesical micro-tip sensor catheter. Before cystometry the bladder was emptied through the lumen of the transurethral catheter and then filled with sterile saline at body temperature and a filling speed of 50 ml. per minute with the patient in the supine position. During the entire recording the subtraction of vesical and abdominal pressure was examined every minute by asking the patient to cough during the filling phase. When standing up to void and when lying down after voiding, subtraction was again examined by coughing to ensure that the catheters were not dislocated. The pressure and flow data were recorded with commercially available equipment. The digitally stored data were translated to a urodynamic analysis computer program, developed at our department. Precise fitting of the automatically computed curves, with correction for pressure or flow artifacts, was done by hand. Patients with detrusor failure or urinary retention were excluded from this study.
Different parameters were used to document obstruction, including the detrusor pressure at maximum flow rate (grad- 
ing according to the Abrams-Griffiths nomogram), intersection of quadratic urethral resistance relation with the pres- sure axis of pressure flow (urethral resistance relation), 9, 10 parameters calculated from the passive urethral resistance relation 12-14 (minimal detrusor pressure with ongoing flow and theoretical cross-sectional area of the urethra) and linear passive urethral resistance relation (an approximation of the resistance relation by means of a straight line through min- imal detrusor pressure and detrusor pressure at maximum flow rate with grading according to the Schäfer nomogram). 14 The majority of patients studied were classified as having urodynamic obstruction depending on the urodynamic pa- rameter used.

Before laser treatment, a suprapubic catheter was inserted for continuous flow through the endoscopic instruments. The day after laser treatment the patients were discharged from the hospital with the suprapublic catheter in situ. At the outpatient clinic the catheter was removed when voiding was satisfactory without a significant post-void residual volume. At 4, 12 and 26 weeks the patients were evaluated with blood studies and urinalysis, uroflowmetry, and international prostatic symptom score, quality of life and sexual function ques- tionnaires. At week 26 urodynamic investigations, transre- ctal ultrasound of the prostate and cystoscopy were repeated. The Wilcoxon signed-rank test was used for statistical com- 

## RESULTS

To date 40 of the 125 patients treated were evaluable for urodynamic analysis 6 months after laser prostatectomy. Mean patient age in this group was 63.8 years (range 51 to 76). Mean values at baseline for patient age, prostatic size, peak urinary flow rates, post-void residual volume and international prostate symptom scores for the complete group are shown in table 1.

The changes in the parameters used are shown in table 2. All patients had an improvement in symptom scores. A mean international prostate symptom score at baseline of 21.7 ± 6.7 (range 12 to 35) improved to 6.3 ± 4.6 with an individual improvement of 15.4 ± 8.1 at 6 months. Mean peak urinary flow rate improved from 8.0 ± 3.1 ml. per second (range 2.0 to 14.0) preoperatively to 17.1 ± 5.9 ml. per second (range 3.9 to 30) at 6 months. The mean individual improvement in peak urinary flow rate was 9.0 ± 6.2 ml. per second (range −3.1 to 20.0). The post-void residual volume decreased from a mean 89.2 ± 102.3 ml. (range 0 to 350) at baseline to 18.2 ± 38.4 ml. (range 0 to 190) with a mean improvement of 71.0 ± 102.3 ml. (range — 135 to 350) at 6 months. All of these parameters demonstrated a statistically significant improve- ment (p <0.0001). Table 2 also shows the improvements in mean values of the urodynamic parameters for the pressure-flow analysis at baseline and at 6 months, all of which were statistically significant (p <0.0001).

For each different fiber the changes in the parameters are shown in table 3. No major differences in these parameters among the 3 different fibers were noted. For the Ultrafine and Urolase fibers a statistical improvement was noted in all parameters. Although an absolute improvement was noted in all parameters, for the TULIP device there was no statistical improvement in post-void residual volume, detrusor pressure at maximum flow rate and minimal detrusor pressure. The few patients in the TULIP group (7) should be considered.

Dependent on what obstruction parameter was used, the incidence of preoperative urodynamic obstruction ranged from 65 to 90%. Postoperatively 8 to 18% of the patients still can be considered as having obstruction (table 4). Figure 1 shows the preoperative and postoperative values for detrusor pressure at maximum flow rate in all patients using the nomogram of obstruction reported by Abrams and Griffiths. 11 Figure 2 is a visual representation of the urodynamic param- 

### TABLE 1. Baseline characteristics of 40 patients

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean ± SD (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs.)</td>
<td>63.8 ± 6.4 (51–76)</td>
</tr>
<tr>
<td>Prostate vol. (cm.³)</td>
<td>46.9 ± 16.9 (24–83)</td>
</tr>
<tr>
<td>Symptom score</td>
<td>21.7 ± 8.6 (12–35)</td>
</tr>
<tr>
<td>Maximum flow rate (ml/sec)</td>
<td>8.0 ± 3.1 (2.0–14.0)</td>
</tr>
<tr>
<td>Post-void residual urine (ml)</td>
<td>89.2 ± 102.5 (0–350)</td>
</tr>
</tbody>
</table>
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Table 2. Urodynamic changes and symptom score improvement before and 6 months after laser prostatectomy in 40 patients

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Before</th>
<th>After</th>
<th>Individual Improvement</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptom score</td>
<td>21.7 ± 6.7</td>
<td>6.3 ± 4.6</td>
<td>15.4 ± 8.1</td>
<td>0.0001</td>
</tr>
<tr>
<td>Post-void residual urine (ml)</td>
<td>89.2 ± 102.6</td>
<td>18.2 ± 38.4</td>
<td>71.0 ± 102.3</td>
<td>0.0001</td>
</tr>
<tr>
<td>Free flow maximum flow rate (ml/sec.)</td>
<td>8.0 ± 3.1</td>
<td>17.1 ± 6.9</td>
<td>8.0 ± 6.3</td>
<td>0.0001</td>
</tr>
<tr>
<td>Detrusor pressure at maximum flow rate (cm. water)</td>
<td>78.7 ± 24.3</td>
<td>35.3 ± 15.6</td>
<td>43.4 ± 29.8</td>
<td>0.0001</td>
</tr>
<tr>
<td>Urethral resistance relation (cm. water)</td>
<td>45.5 ± 22.4</td>
<td>18.7 ± 8.6</td>
<td>26.8 ± 22.6</td>
<td>0.0001</td>
</tr>
<tr>
<td>Minimum detrusor pressure (cm. water)</td>
<td>41.3 ± 23.9</td>
<td>17.3 ± 10.0</td>
<td>25.4 ± 28.1</td>
<td>0.0001</td>
</tr>
<tr>
<td>Theoretical cross-sectional urethral area (mm.²)</td>
<td>2.3 ± 1.1</td>
<td>7.5 ± 4.1</td>
<td>5.2 ± 4.1</td>
<td>0.0001</td>
</tr>
<tr>
<td>Linear passive urethral resistance relation</td>
<td>3.6 ± 1.5</td>
<td>1.5 ± 1.0</td>
<td>2.1 ± 1.5</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Table 3. Mean improvement (plus or minus standard deviation) in different parameters for each different fiber at baseline and at 6-month followup

<table>
<thead>
<tr>
<th>Parameter</th>
<th>TULIP (7 pts.)</th>
<th>Urolase (19 pts.)</th>
<th>Ultraline (14 pts.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptom score</td>
<td>21.8 ± 8.0</td>
<td>22.4 ± 0.0</td>
<td>20.8 ± 7.3</td>
</tr>
<tr>
<td>Free flow maximum flow rate (ml/sec.)</td>
<td>8.4 ± 2.2</td>
<td>8.1 ± 3.3</td>
<td>7.6 ± 3.3</td>
</tr>
<tr>
<td>Post-void residual urine (ml)</td>
<td>68 ± 70</td>
<td>80 ± 107</td>
<td>111 ± 111</td>
</tr>
<tr>
<td>Detrusor pressure at maximum flow rate (cm. water)</td>
<td>81 ± 48</td>
<td>72 ± 91</td>
<td>81 ± 32</td>
</tr>
<tr>
<td>Urethral resistance relation (cm. water)</td>
<td>53 ± 33</td>
<td>46 ± 22</td>
<td>50 ± 16</td>
</tr>
<tr>
<td>Minimum detrusor pressure (cm. water)</td>
<td>46 ± 33</td>
<td>40 ± 22</td>
<td>41 ± 19</td>
</tr>
<tr>
<td>Theoretical cross-sectional urethral area (mm.²)</td>
<td>2.3 ± 1.3</td>
<td>2.4 ± 1.0</td>
<td>2.1 ± 1.1</td>
</tr>
<tr>
<td>Linear passive urethral resistance relation</td>
<td>3.7 ± 1.1</td>
<td>3.5 ± 1.4</td>
<td>3.8 ± 1.4</td>
</tr>
</tbody>
</table>

* Not significant.

Fig. 1. Changes in detrusor pressure (Pdet) at maximum flow rate (Qmax) before and 6 months after laser prostatectomy using Abrams-Griffiths nomogram11 for obstruction in all 40 patients.

The majority of our patients, based on different urodynamic parameters, can be considered to have obstruction. It appears that laser treatment is capable of relieving uroynamically verified outlet obstruction. Although symptoms improved in all patients, there was no clear correlation between the extent of obstruction relieved and improvement in symptoms (figs. 3 to 7), which underlines again the discrepancy between objective and subjective parameters. It is also known that patients with poor urine flow due to weak detrusor contractions are those who respond worse to prostatectomy.17, 19, 20 Our study shows that patients considered not to have obstruction also improved well, depending on which parameter was used to determine obstruction. Although the changes in obstructive parameters among these patients are less pronounced, which is to be expected because they have less to gain, the symptomatic improvement is considerable (figs. 3 to 7). Regarding laser treatment for BPH, studies in patients with less obstruction are mandatory to determine if laser is also capable of achieving substantial subjective and objective improvement. On the other hand, in symptomatic patients with less obstruction other minimal invasive therapies, for example medical treatment or transurethral microwave thermotherapy, should be considered.

Comparing our study to the data in the literature on urodynamic changes after transurethral resection of the prostate, a similar improvement in urethral resistance relation is noted.17 The changes in detrusor pressure at maximum flow rate and in the curves of the pressure-flow plot after laser
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A considerable number of studies concerning laser treatment have been published, and many different fibers and energy settings have been used. To date no major differences in outcome have been reported using these different fibers. The general results are the same and are comparable with results after transurethral resection of the prostate.\textsuperscript{2-7} In our study 3 different types of fibers were used. Although not randomized and with few patients in each group, no differences in the extent of obstruction relieved among these 3 fibers could be found (table 3). Laser energy seems to be capable of relieving outlet obstruction. The method of applying the energy appears to be secondary, and the treatment success depends largely on the preference and skills of the surgeon in using the various techniques. The different morbidity rates caused by the various fibers and techniques should also be considered. The long-term results may be different for each fiber or technique used and related to the ability to create cavities.

Transurethral resection of the prostate remains the gold standard in the treatment of BPH to which all other new treatment modalities should be compared. The objective of surgical treatment for prostatic obstruction must be to relieve obstruction safely and effectively no matter what procedure or technique is used. The reasons for considering transurethral resection of the prostate as the most effective therapy are the excellent objective and subjective results reached and sustained for a long period. To date none of the alternative treatments has accomplished similar or even better results. With regard to laser prostatectomy, improvements in symptoms and uroflowmetry are impressive, and to a great extent comparable to the results reached after transurethral resection of the prostate.\textsuperscript{2-6} However, long-term effects are not yet available and only speculations can be made about the final effect in the future.\textsuperscript{29,30} A possibility to predict a long lasting effect might be the presence of a cavity on urethrocystoscopy or transrectal ultrasound of the prostate as a result of laser therapy. Moreover, the changes in obstructive voiding to nonobstructive voiding measured in a pressure-flow analysis can contribute to a more accurate prediction.

We are aware that controversy still exists about whether to perform a complete urodynamic evaluation routinely in pa-

![Fig. 3](https://example.com/fig3.png)

**Fig. 3.** Correlation between improvement in symptom score (IPSS) and improvement in urethral resistance relation (URA, intersection of quadratic urethral resistance relation with pressure axis in pressure-flow plot in cm. water) for all 40 patients after laser treatment. ▲, patients who at baseline could not be considered to have obstruction.

![Fig. 4](https://example.com/fig4.png)

**Fig. 4.** Correlation between improvement in symptom score (IPSS) and improvement in minimal detrusor pressure with ongoing flow in cm. water (\(P_{\text{voidmin}}\)) for all 40 patients after laser treatment. ▲, patients who at baseline could not be considered to have obstruction.

![Fig. 5](https://example.com/fig5.png)

**Fig. 5.** Correlation between improvement in symptom score (IPSS) and improvement in theoretical cross-sectional (\(A_{\text{tho}}\)) area of urethra in mm.\(^2\) for all 40 patients after laser treatment. ▲, patients who at baseline could not be considered to have obstruction.

![Fig. 6](https://example.com/fig6.png)

**Fig. 6.** Correlation between improvement in symptom score (IPSS) and improvement in detrusor pressure (\(P_{\text{det}}\)) at maximum flow rate (\(Q_{\text{max}}\)) in cm. water for all 40 patients after laser treatment. ▲, patients who at baseline could not be considered to have obstruction.
obstructed patients who at baseline could not be considered to have obstruction.

The IPSS-lmprovement after laser treatment was analyzed. Results showed a significant improvement in the obstructive symptoms for all 40 patients after laser treatment. Moreover, we must determine the role of routine urodynamic investigation in the assessment of BPH in daily urological practice. More specifically, to solve the question of which fiber or technique used is best suitable for patients for different (alternative) treatment options, interest must be demonstrated to the type and grade of obstruction but also to select patients with BPH, and about the clinical relevance of precisely grading the obstruction. We believe that to date urodynamic investigations with pressure-flow analysis should first be considered as an essential research tool to evaluate best the outcome of alternative treatments for BPH. Moreover, we consider it essential to establish the safety, efficacy and cost of laser ablation of the prostate and urethral microwave thermotherapy could be predicted from pressure-flow analysis, making patient selection possible.31 Finally, to solve the question of which fiber or technique used is superior in providing long lasting relief of obstruction, randomized studies with obligitory urodynamic and pressure-flow analysis evaluation of treatment outcome are necessary.

CONCLUSIONS

Urodynamic evaluation with pressure-flow analysis of treatment outcome after laser prostatectomy shows that laser is capable of relieving outflow obstruction comparable to results obtained with transurethral resection of the prostate. No apparent difference in ability to relieve obstruction was shown for the different fibers and techniques. To evaluate the ability to provide long lasting relief of obstruction for each different fiber, randomized studies with urodynamic evaluation and pressure-flow analyses are mandatory.

REFERENCES


